M.Sc. DEGREE IN PHYSICS

CHOICE BASED CREDIT SYSTEM

(Effective from the Academic Year 2018-2019)

DEPARTMENT OF PHYSICS
YOGI VEMANA UNIVERSITY
KADAPA - 516003
April 2018

COURSE STRUCTURE AND EXAMINATION SCHEME for M.Sc. (Physics)

Semester	Course code	Title of the Course	No. of credits	No. of hours per week	Max. Marks 100		Total
					Internal Assess-ment	End Exams	
SEMESTER I	PHY 15101	Classical Mechanics and Theory of Relativity	04	04	25	75	100
	PHY 15102	Atomic and Molecular Physics	04	04	25	75	100
	PHY 15103	Solid State Physics	04	04	25	75	100
	PHY 15104	Analog and Digital Electronics	04	04	25	75	100
	PHY 15105	Practical - I (General)	04	12		100	100
	PHY 15106	Practical-II (Electronics)	04	12		100	100
SEMESTER II	PHY 15201	Statistical Mechanics	04	04	25	75	100
	PHY 15202	Electromagnetic Theory, Lasers and Modern Optics	04	04	25	75	100
	PHY 15203	Mathematical Physics	04	04	25	75	100
	PHY15204	Computational Methods and Programming	04	04	25	75	100
	PHY 15205	Practical - I (General)	04	12		100	100
	PHY 15206	Practical-II (Computer Lab.)	04	12		100	100
	PHY 15207	***Non-Core: Frontiers of Physics***	04	04	25	75	100
SEMESTER III	PHY15301	Quantum Mechanics – I	04	04	25	75	100
	PHY15 302	Nuclear and Particle Physics	04	04	25	75	100
	PHY 15303	Physics of Semiconductor Devices	04	04	25	75	100
	PHY 15304 **Special Paper 1**	(A) Condensed Matter Physics (CMP)-I: Physics of Crystalline Materials (B) Electronics-I : Advanced Electronics	04	04	25	75	100
	PHY 15305	Practical - I (General)	04	12		100	100
	PHY 15306	Practical-II (CMP/Electronics)	04	12		100	100
	PHY 15307	***Non-Core: Advanced analytical Instruments***	04	04	25	75	100
SEMESTER IV	PHY15401	Quantum Mechanics – II	04	04	25	75	100
	PHY15 402	Analytical Techniques	04	04	25	75	100
	PHY 15403 **Elective***	(A) AtmosphericPhysics (B) Applied Spectroscopy (C) Vacuum and Thin Film Physics (D) Photonics	04	04	25	75	100
	PHY 15404 **Special Paper 2**	(A) Condensed Matter Physics (CMP)-II: (B) Electronics II: Communication Systems	04	04	25	75	100
	PHY 15405	Practical - I (Elective)	04	12		100	100
	PHY 15406	Practical-II (CMP/Electronics)	04	12		100	100
Total for CorePapers			**96**	**160**	**400**	**2000**	**2400**
Total for Non-CorePapers			**08**	**08**	**50**	**150**	**200**

NON-CORE COURSES
(FOR THE STUDENTS OF OTHER DEPARTMENTS)

COURSE CODE	TITLE
PHY 15207	Analytical Methods
PHY 15307	Remote Sensing and Applications

Note: The Department will offer both External Elective Courses depending on the student's strength opted for that course, which will be intimated at the beginning of the semester.

PHY 15101: CLASSICAL MECHANICS AND THEORY OF RELATIVITY

UNIT – I: Lagrangian Mechanics and Hamiltonian Mechanics

Newtonian mechanics of one and many particle systems: Conservation laws, Constraints and their classification, Degrees of freedom: Generalized coordinates: Principle of virtual work, D'Alemberts principle, Lagrange's equations of motion. Applications: Inclined plane, Linear harmonic oscillator and simple pendulum.

Hamiltonian principle, Lagrange's equation from Hamilton's principle, Hamilton's equation of motion. Applications: Simple pendulum, Compound pendulum. (1-4)

UNIT – II: Canonical Transformations and Hamilton - Jacobi Theory

Canonical Transformations, Generating function and their properties, Condition for transformation to be canonical, Illustration of canonical transformation, Poisson – Brackets, Canonical equations in terms of Poisson, Bracket notation. Lagrange - Brackets and their properties.

Hamiltonian - Jacobi equation, one dimensional harmonic oscillator, Small oscillations and normal modes, Action Angle variables, Kepler problem in action angle variables. (4,5)

UNIT –III: Motion in a Central Force Field

Reduction to the equivalent one body problem; Motion in a central force field: Conditions for closed orbits: Inverse square law of forces: Kepler's laws of planetary motion; Rutherford scattering.

Rotations – Space and body fixed axes: Angular momentum and Torque; Eulerian angles – Euler's equations of a rigid body: Motion of symmetrical top ; Expression for slow and fast precessions; Larmour precision; Gyroscope. (1-3,6)

UNIT –IV: Special Theory of Relativity

Introduction – Postulates of Special Theory of Relativity – The principle of constancy of light – The Lorentz transformations. Relativistic Kinematics: The velocity transformations – The transformations for the acceleration of a particle, The Doppler effect.

Relativistic Mechanics: The mass of a moving particle – The relativistic dynamics of a single particle – Applications of relativistic dynamics of a single particle : Motion in electric field – Motion in a magnetic field – Experimental verification of the variation of mass with velocity – Bucherer's experiment - Transformation of momentum and force. (7-9)

Books for Reference

1. Classical Mechanics by N.C. Rana and P.S. Joag (Tata Mc-graw Hill) 1991
2. Classical Mechanics by H. Goldstein (Addi Wesely) 1980
3. Classical Mechanics by J.C.Upadyaya
4. Classical Mechanics by Gupta, Kumar and Sharma
5. Classical dynamics of particles by J.B.Narion Academic press
6. Introduction to Classical Mechanics by R.G. Takwale and P.S. Puranic
7. Theory of Relativity by W.Pauli
8. Introduction to the theory of relativity by P.G.Bergmann
9. Introductory Relativity by W.G.V.Rossner

PHY 15102: ATOMIC AND MOLECULAR PHYSICS

UNIT I: Atomic Spectra

Hydrogen atom (one electron atom) - quantum numbers- Spectra of hydrogen atom- Spectra of alkali elements- Fine structure- Elements with more than one valence electron- Forbidden transitions and selection rules- Vector atom model – Spin-orbit interaction energy- Space quantization- Stern-Gerlach (S-G) experiment-Coupling schemes- Spectral terms and term symbols, Ground states based on electron configuration - LS coupling - JJ coupling- Interaction energies in LS and JJ couplings - Hund's rule of multiplicity - Pauli's exclusion principle - Equivalent and non-equivalent electronic systems – Applications of atomic spectra.

UNIT II: Zeeman and Stark Effects

Zeeman effect, Normal and anomalous Zeeman effects, Experimental details, Zeeman effect of hyperfine structure, Magnetic moment of the atom and Lande's 'g'-factor, Zeeman effect in sodium atom, Lande g-formula for LS and JJ couplings - Paschen-Back effect- Splitting of sodium lines and selection rules, Stark effect, Experimental details, Weak and strong field effects- linear and quadratic Stark effects-Width of spectral lines.

UNIT III: Diatomic Molecular Spectroscopy – Rotational Energies

Rotational, vibrational, electronic spectra of diatomic molecules, Types of molecules: Linear, symmetric top, asymmetric top and spherical top molecules, Rotational spectra of a diatomic molecule as rigid rotator – Energy levels and spectra of non-rigid rotor – Intensity of rotational lines - Rotational spectra of polyatomic molecule (OCS, CO_2) -Evaluation of rotational constants -Effect of isotopic substitution on rotational levels- Stark modulated microwave spectrometer- Applications of rotational spectroscopy - Determination of molecular structure, dipole moment, atomic mass- Microwave oven.

UNIT IV:Diatomic Molecular Spectroscopy – Vibrational Spectra

Vibrational spectra of diatomic molecule – Diatomic molecule as simple harmonic oscillator – Anharmonic oscillator – Energy levels and spectrum – Molecule as vibrating rotator – PQR branches – progressions and sequences – Vibrational analysis of electronic spectra - Deslander's table – Evaluation of vibrational constants – Morse potential energy curve – Frank-Condon principle – Intensity distribution in absorption and emission spectra - Effect of isotopic substitution on vibrational bands – IR spectrometer – FTIR spectroscopy – Principle – Interferometer arrangement – advantages - Applications of vibrational spectroscopy: Identification of molecular constituents – Elucidation of molecular structure.

Books for study

1. Introduction to Atomic Spectra, H.E. White, McGraw-Hill Kogakusha. Ltd., New Delhi.
2. Fundamentals of Molecular Spectroscopy, C.N. Banwell and E.M.Mc Cash, Tata McGraw-Hill Pub. Co. Ltd., New Delhi,1994.
3. Spectroscopy, Vol. I & III, B.P. Straughan& S. Walker, John Wiley & Sons, Inc., NY,1976.
4. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw - Hill Book Co, 1962.
5. Spectra of Diatomic Molecules, G. Herzberg, D.VanNostrand Company Inc, New York 1950.
6. Molecular Spectroscopy, J.M. Brown, Oxford Science Pub. Oxford, 1998.
7. Molecular Structure and Spectroscopy, G. Aruldhas, Prentice- Hall of India, Pvt., 2005.
8. Elements of Diatomic Molecular Spectra by H. Dunford – Addison-Wisely, 1957.

PHY 15103: SOLID STATE PHYSICS

UNIT – I: Lattice Energies and Lattice Vibrations

Bonding in Solids - Ionic and van der Waals crystals – Elastic properties – Stress and strain – Elastic moduli - Lattice energy calculations for ionic and van der Waals crystals – Lattice vibrations: Mono and diatomic one dimensional infinitely long lattices – Vibrational spectra – Infrared absorption in ionic crystals – Vibrational spectra of finite lattice – Quantization of lattice vibrations – Phonons – Properties – Experimental measurement of dispersion relation.

UNIT – II: Transport Phenomena and Band Theory

Concept of electrical and thermal resistivity – Expression for thermal and electrical conductivities for metals – Lorenz number - Different scattering mechanisms – Matthissen's rule- Formulation of Boltzmann transport equation – Relaxation time approximation

Free electron theory - Band theory of Solids - Motion of electron in periodic potential – Bloch function - Kroning-Penny model – Formation of energy bands in solids — Brillouin zones – Concept of effective mass – Distinction between metals, insulators and semiconductors.

UNIT – III: Semiconductor Physics

Intrinsic and extrinsic semiconductors – Expression for position of Fermi levels and carrier concentrations – Variation of Fermi level with temperature – np product – Degenerate and non-degenerate semiconductors – Charge neutrality equation - Carrier mobility, conductivity and their variation with temperature – Direct and indirect band gap semiconductors – Differences and examples – Hall effect – Drift and Diffusion – Diffusion equation - Einstein relation – Generation, Recombination and life time of non-equilibrium carriers – Hayness-Shockley experiment.

UNIT – IV: Superconductivity

Concept of zero resistance – Magnetic behavior –Meissner effect – Type I and Type II superconductors - Isotope effect – Specific heat behavior –Expression for entropy difference between normal and superconducting states – Two-fluid model – London's equations – Penetration depth – BCS theory –Josephson junctions – SQUIDS - Applications of superconductors – High T_C superconductors (Conceptual)

Books for Study

1. Solid State Physics, C. Kittel, John Wiley & Sons.
2.Solid State Physics, Neil W. Ashcroft & N David Mermin
3. Solid State Physics, A.J. Dekkar, Macmillan India Ltd.
4. Elementary Solid State Physics, M. Ali Omar, Addison-Wesley.
5. Solid State Physics, M.A.Wahab, Narosa Publishing House.
6. Solid State Electronic Devices, B.G. Streetman.
7.High T_C Superconductivity, C.N.R. Rao and S.V. Subramanyam.
7. Solid State Physics, S.O. Pillai.
8. Electrons in Solids, Richard H. Bube.
9. Semiconductor Device fundamentals, Robert F. Pierret, Addison and Wesley Longmann

PHY 15104: ANALOG AND DIGITAL ELECTRONICS

UNIT – I: Introduction to Electronic Devices:

P-N junction and its characteristics, BJT, characteristics, BJT as amplifier, Field Effect Transistor (FET): Structure and working of JFET, Characteristics, and parameters of JFET. Advantages of FET over BJT. FET as switch and Amplifier Application of FET as voltage variable resistor. Structure of MOSFET, depletion type and enhancement type, MOSFET Characteristics, MOSFET as variable resistor, Concept of CMOS. Structure, working and Characteristics of UJT. Application of UJT as a Relaxation oscillator.

UNIT – II:

Operational Amplifiers:

Block diagram of a typical Op-Amp, differential Amplifier, Comparator open loop configuration, inverting and non-inverting amplifiers. Op-amp with negative feedback, CMRR, frequency response, slew rate. Instrumentation Amplifier, Integrator and differentiator. Waveform generators (Square and triangle). Converters: R-2R Ladder D/A Converter, Successive Approximation A/D Converter.

UNIT – III : Digital Electronics

Combinational Logic: Multiplexers, Decoder, Demultiplexer, Data selector, Multiplexer, Encoder. Sequential Logic: Flip–Flops, 1-bit memory, The RS Flip-Flop, JK Flip – Flop, JK Master Slave Flip–Flops, T Flip-Flop, D Flip-Flop, Shift Registers, Serial in Serial out, Serial in Parallel out, parallel in Serial out, Parallel in Parallel out Registers. Counters: Asynchronous and Synchronous Counters, MOD-3 Counter, MOD-5 Counter.

UNIT – IV: 8085 Microprocessor

Introduction to microcomputers, memory, input/output, interfacing devices, 8085 CPU-Architecture-BUS timings Demultiplexing the address bus generating control signals, instruction set, addressing modes, illustrative programs – writing assembly language programs, looping, counting and indexing counters and timing delays, stack and subroutine.

Text Books

1. Micro Electronics by Milliman and Halkias. TMH Publications
2. OP-Amps & Linear Integrated Circuits, by Ramakanth A.Gayakwad, PHI, 2nd Edition, 1991.
3. Digital Systems by Ronald J. Tocci, 6th Edition, PHI, 1999.
4. Digital Principles and Applications by A.P. Malvino and Donald P.Leach, Tata McGraw- Hill, New Delhi, 1993.
5. Microprocessor Architecture, Programming & Appplications with 8085/8086 by Ramesh S.Gaonkar, Wiley – Eastern Ltd, 1987 (UNIT – V)

Reference Books

1. Electronic Devices and Circuit Theory by Robert Boylested and Louis Nashdsky, PHI, New Delhi, 1991
2. Micro Electronics by Sedra and Smith
3. Electronic Principles by Malvino, 6th Ed. TMH
4. Linear Integrated circuits by Roy Choudhry
5. Operational amplifiers by Collins

PHY 15201: STATISTICAL MECHANICS

UNIT- I: Ensembles

Phase space – Macro and micro states - Contact between Statistics and Thermodynamics - Concept of ensembles – Types of ensembles - Ensemble average - Liouville's Theorem – Micro canonical ensemble: ideal gas – Gibb's paradox and its resolution – Entropy and probability – Canonical ensemble – Ideal gas in canonical ensemble – Grand canonical ensemble – Ideal gas in grand canonical ensemble – Comparison of various ensembles.

UNIT – II: Partition Functions

Canonical partition function – Free energy and relation with thermodynamic quantities - Molecular partition function – Translational partition function – Rotational partition function – Vibrational partition function – Electronic and Nuclear partition functions – Applications of Rotational partition function – Applications of vibrational partition function to solids.

UNIT – III: Maxwell – Boltzmann and Bose – Einstein Statistics

Classical and Quantum Statistics - Maxwell - Boltzmann distribution –Density of States - Velocity and Energy distribution - Calculation of mean values – Equipartition theorem - Bose – Einstein distribution, Bose – Einstein condensation - Black body radiation and the Planck's radiation law - Dulong and Petit's law - Einstein and Debye's theories of heat capacities - Liquid helium – Two fluid model of liquid helium II.

UNIT – IV: Fermi – Dirac Statistics & Fluctuations

Fermi - Dirac distribution – Electrons in metals – Thermionic emission – Magnetic susceptibility of free electrons – White dwarfs – Fluctuations in ensembles, Onsagar's one dimensional and reciprocal relations - Ising Model - Random walk and Brownian motion, First and second order phase transitions.

Books for study

1. Statistical Mechanics ,B.K. Agarwal, Melvin Eisner,2nd Edition, New Age International (P)Ltd.
2. Statistical Mechanics and properties of Matter by ESR Gopal — Student Edition (EllisHorwood)
3. Statistical and Thermal Physics ,F. Reif—4thEdition,McGraw Hill
4. Statistical Mechanics, R.K. Pathria and Paul D. Beale, Elsevier
5. Fundamentals of Statistical Mechanics, B.B. Laud, New Age International Publishers
6. Elementary Statistical Mechanics, S.L. Guptha and V. Kumar, PragathiPrakashan Publications

Books for reference:

1. Statistical Physics,Bhattacharjee
2. Introduction to Modern Statistical Mechanics, David Chandler, Oxford University Press

PHY 15202: ELECTROMAGNETIC THEORY, LASERS AND MODERN OPTICS

UNIT – I: Electromagnetic Theory

Maxwell's equations in differential and integral forms, Scalar and Vector potentials- Gauge invariance, The general wave equation, Propagation of light in isotropic dielectric medium – Dispersion, Propagation of light in conducting medium-skin depth, Reflection and refraction at the boundary of a dielectric interface – Fresnel's equations- Propagation of light in crystals- Double refraction. Electromagnetic radiation ; Retarded potentials, Radiation from moving point charge, Radiation from oscillating dipole (electric and magnetic dipoles), Radiation from linear antenna – Radiation resistance, electric quardrupole radiation, Lienard – Wiechert potentials.

UNIT – II: Lasers and Non-Linear Optics

Basic principles of lasers – Spontaneous and stimulated emission – Laser beam properties - Einstein coefficients - Population inversion – Pumping schemes – Threshold condition for laser oscillation –Types of lasers- Ruby laser-Nd:YAG laser - GaAs laser, -Dye laser - Argon ion laser-CO_2 laser - rate equations for three level and four level lasers-Laser applications.

Basic Principles – Origin of optical nonlinearity - Harmonic generation – Second harmonic generation – Phase matching condition – Third harmonic generation – Optical mixing – Parametric generation of light – Parametric light oscillator – Frequency upconversion – Self focusing of light - Guided wave optics - Pulse compression - Optical solutions.

UNIT – III: Holography and Fourier Optics

Introduction to Holography – Basic theory of Holography – Recording and reconstruction of Hologram – Diffuse object illumination – Speckle pattern – Fourier transform Holography – Applications of Holography.

Introduction to Fourier optics– Two dimensional Fourier transforms – Transforms of Dirac-Delta function – The convolution integral – convolution theorem- Spectra and correlation – Parsevel's formula – Auto correlation and cross-correlation – Apodization – Array theorem – Fourier methods in diffraction - Fraunhouffer diffraction of single slit, double slit and transmission grating using Fourier method.

UNIT – IV: Fiber Optics

Total internal reflection - Optical fiber modes - TE and TM modes– Single mode fibers – Graded index fibers – Fiber materials and fabrication – Mechanical properties of fibers – Fiber optic cables – Attenuation – Signal distortion on optical wave guides- Erbium doped fiber amplifiers – Solitons in optical fibers - Block diagram of fiber optic communication system - Applications of optical fibers in communication and medicine.

Text and Reference Books

1. Introduction to Electrodynamics, D.J. Griffiths, 4 th Edition, Prentice-Hall of India, ND,2513.
2. Electromagnetics, B.B. Laud, 3rd Edition, New Age International Publishers Ltd, ND, 2511.
3. Fundamentals of Electromagnetic theory, 2nd Edition, S.K. Dash and S.R. Khuntia, ND,2511.
4. Modern Optics by G.R. Fowels, 1989.
5. Laser and their Applications, M.J. Beesly, Taylor and Francis, 1976
6. Lasers and Non-Linear Optics, B.B. Laud, 3rd Edition, New Age International Publishers Ltd, New Delhi, 2511.
7. Optics, E. Hecht, Addison Wiley,1974.
8. Optical Fiber Communications, Gerel Keiser, McGraw Hill Book, 2500.

PHY 15203: MATHEMATICAL PHYSICS

UNIT - I: Special Functions

Beta and Gamma Functions – Definitions and properties – Evaluation of integrals, Legendre, Bessel and Hermite differential equations – Solutions – Generating functions – Orthogonal properties of Legendre, Bessel and Hermite Functions (Proof not necessary) – Recurrence relations – (Proof for Legendre polynomials only)

UNIT - II: Integral Transforms

Laplace Transform: Properties of Laplace transforms **–**Derivative of Laplace transform– Laplace transform of a derivative –Laplace transform of periodic functions- Inverse Laplace transform and its properties –Inverse Laplace theorem –Convolution theorem-Evaluation of inverse Laplace Transforms by Convolution theorem. Solution of linear differential equations with constant coefficients - Applications to LCR circuits, Operational amplifiers and resonance of simple pendulum.

Fourier Transform: Infinite Fourier Sine and Cosine transforms–Properties of Fourier transforms - Derivative of Fourier transform –Fourier transform of a derivative- Fourier Sine and Cosine transform of derivatives-Finite Fourier transforms – Applications of Fourier Transforms.

UNIT - III: Partial Differentiations and Tensors

Partial Differentiations: Laplace equation – Method of separation of variables – Application of Laplace equation to two dimensional steady state of heat flow in a thin rectangular plate and a long cylinder. Wave equation in two dimensions – Application to the vibration of a rectangular membrane and circular membrane.

Tensors: Definition – Contravariant, Covariant and Mixed tensors – Dummy suffix notation-Addition, subtraction, contraction, inner product, outer product, symmetric and anti-symmetric tensors - Application of Tensor theory to strain, thermal expansion and piezoelectricity.

UNIT – IV: Complex Variables

Functions – Complex differentiation - Analytic function - Cauchy – Reimann equations – Derivatives of elementary functions – Singular points and classification. Complex integration - Cauchy's theorem – Integrals of special functions – Cauchy's integral formula – Taylor's and Lorentz theorem (statements only) – Residues, calculations of residues - Residue theorem – evaluation of definite integrals.

Reference Books

1. Functions for Scientists and Engineers, W.W. Bell, Van Nostrand Co., London (1968).
2. Fourier Analysis, Hsu P.Jewi, Unitech Division.
3. Laplace Transforms, Murray Spiegle, Schaum's outline series, McGraw Hill,New York.
4. Applied Mathematics for Engineers, Pipes and Harval, III Edition, McGrawHill Books Co.
5. Vector Analysis & Introduction to Tensor Analysis, M. R. Spiegel, Schaum's Series 1959.
6. Physical Properties of Crystals, J.F. Nye, Schaum'sSeries, Oxford Univ. Press, 1957.
7. Theory and Properties of Complex Variables, S. Lipschutz, Schaum'sSeries, McGraw Hill.
8. Mathematical Physics, H.K. Das and Ramaverma, S. Chand & Co. Ltd., New Delhi (2011).
9. Mathematical Physics, B. Bhattacharyya, New Central Book Agency Pvt. Ltd., (2010).
10. Applied Mathematics for Engineers and Physicists –Lious A Pipes and Lawrance R. Rarvill.
11. Mathematical Physics –AK Ghatak, IC Goyal and SL Chua-Macmillan India Ltd
12.. Vector and Tensor Analysis –Scham Series.
13.. Mathematical Physics –SatyaPrakash

PHY 15204: COMPUTATIONAL METHODS AND PROGRAMMING

UNIT – I: C programming language

(a) Fundamentals of C

C character set – Identifiers and keywords – Constants – Variables – Data types – Declarations of variables – Declaration of storage class – Defining symbolic constants – Assignment statement. Operators : Arithmetic operators – Relational operators – Logic operators – Assignment operators – Increment and decrement operators – Conditional operators.

(b) Expressions and I/O statements: Arithmetic expressions – Precedence of arithmetic operators – Type converters in expressions – Mathematical (library) functions – Data input and output - Getchar and putchar functions – Scanf – Printf – Simple programs.

(c) Control statements: If-Else statement – Switch statement – The ?Operator – GO TO – While , Do-while, FOR statements – BREAK and CONTINUE statements.

(c) Arrays

One dimensional and two dimensional arrays – Initialization – Type declaration – Inputting and outputting of data for arrays – Programs of matrices addition, subtraction and multiplication.

(d) User Define function: The form of C functions – Return values and their types – Calling a function – Category of functions. Nesting of functions.Recursion.ANSI C functions – Function declaration. Scope and lifetime of variables in functions.

(e) Pointers: Accessing the address of a variable. Declaration and Initialization of pointer variables. Accessing the value of a variable through its pointer. Pointer Expressions- Pointers and arrays – Pointers and structures.

UNIT II – Fundamentals of MATLAB and Applications

Basics of Matlab – Matlab windows- On-line help- Input-Output-File types-Platform Dependence - Creating and working with Arrays of Numbers – Creating, saving, plots, printing Matrices and Vectors – Input – Indexing –Matrix Manipulation-Creating Vectors Matrix and Array Operations Arithmetic operations- Relational operations – Logical Operations – Elementary math functions , Matrix functions – Character strings Applications- Linear Algebra,- solving a linear system, Gaussian elimination, Finding Eigen values and eigenvectors, Matrix factorizations

Application-Curve Fitting and Interpolation-Polynomial curve fitting on the fly , Least squares curve fitting, General nonlinear fits, Interpolations

UNIT – III: Linear, non-linear equations and curve fitting

(a) Solution of Algebraic and transcendental equations – Bisection, Falsi position and Newton- Rhapson methods – Basic principles – Formulae – Algorithms.

(b) Simultaneous equations: Solutions of simultaneous linear equations – Gauss elimination and Gauss-Seidel iterative methods - Basic principles – Formulae – Algorithms

(c) Curve fitting – Least squares fitting – Linear and quadratic equations.

UNIT – IV: (a) Interpolations: Concept of linear interpolation – Finite differences – Newton's and Lagrange's interpolation formulae –Principles and Algorithms

(b) Numerical differentiation and integration: Numerical differentiation – algorithm for evaluation of first order derivatives using formulae based on Taylor's series – Numerical integration – Trapezoidal and Simpson's 1/3 rule – Formulae – Algorithms.

(c) Numerical solution of ordinary differential equations: Euler, method, fourth order Runga-Kutta Method.

Books for reference

1. Programming with 'C', Byron Gottfried, Tata McGraw Hill.
2. Numerical Methods, E. Balaguruswamy, Tata McGraw Hill.
3. Let Us C, Yeswanth Kanetkar.
4. Rudra Pratap, Getting started with Matlab 7, Oxford, Indian University Edition, 2006
5. Y.Kirani Singh and B.B.Chaudhuri, MATLAB Programming, Prentice-Hall India, 2007
6. Computer oriented numerical methods, Rajaraman.

Non-Core Elective Paper

PHY 15207: FRONTIERS OF PHYSICS

Unit I: Contribution of Indian Scientists:

J.C.Bose, Dr.C.V.Raman, S.N.Bose, M.N.Saha, Prof. SatishDhawan, Dr.B.D.NagChaudhary, H.J.Bhabha, Dr.A.P.J.AbdulKalaam, Vikram Sarabhai, Prof.S.Bhagavantham, Prof. C.N.R.Rao

Unit II: Conventional Energy

Role of new and renewable energy source; solar energy-solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion
Wind energy-Sources and potentials, horizontal and vertical axis windmills, performance characteristics
Tidal and wave energy: Potential and conversion techniques

Unit-III Non-conventional Energy

Non-renewable sources such as petroleum, natural gas, coal (Rayalaseema Thermal Power Project and Ramagundam Thermal Power Project)andHydel power plants – Srisailam Hydroelectric power plant and NagarjunaSagar Hydroelectric power plant

Unit IV: Nuclear Energy

Introduction Nuclear Physics concepts; Nuclear power plants – Advantages and disadvantages

1. Kalpakkam Atomic power station
2. Tarapur Atomic power station

Source: The relevant material of the above units must be down loaded from authenticated web location from https://www.google.com

PHY 15301: QUANTUM MECHANICS – I

UNIT - I: Formulation and Simple Problems

Wave particle duality – Wave functions in coordinate and momentum representation- Postulates of quantum mechanics -Linear vector space: Hilbert space - Dirac's Bra and Ket notations- Hermitian operators and their properties- Matrix representation of an operator- Unitary operators- Unitary transformation - The Kronicker Delta and Dirac delta functions

Eigen values and Eigen functions for finite potential well and step barrier – Quantum mechanical tunneling

UNIT - II: Quantum Dynamics and Simple Problems

Equations of motion - Schrodinger Picture- Heisenberg Picture- Interaction Picture- Equivalence of various Pictures- . Poisson and Commutation brackets- Their Properties

Eigen values and Eigen functions for Simple harmonic oscillator- Polynomial method and abstract operator method in one dimension- Eigen values and Eigen functions for a free particle and particle in a box in three dimensions.

UNIT - III: Approximate Methods

Time independent perturbation theory for non-degenerate levels: Perturbed harmonic oscillator, Normal Helium atom, Stark effect of the plane rotator. First order perturbation theory for degenerate levels: First order Stark effecting in hydrogen atom; Time dependent perturbation theory: Transition to continuum (Fermi Golden rule).

WKB approximation – Turning points and connecting formulae: Application to potential barrier. Variational methods.

UNIT - IV: Scattering Theory

Introduction: classical theory of scattering - Quantum theory of scattering - Method of partial wave analysis - Scattering by a perfectly rigid sphere - Greens function in scattering theory - Born approximation - Validity of Born approximation - optical theorem.

Reference Books

1.QuantumMechanics: S.L.Kakani and H.M.Chandalia.SultanChandandSonsFirst Edition
2. Advanced Quantum Mechanics : B.S. Rajput, Pragatiprakasan.
3. Quantum Mechanics: V.K. Thankappan, Wiley Eastern Limited
4. A Textbook of Quantum Mechanics : P.M. Mathews and K. Venkatesan, Tata McGrawHill Publishing Company.
5. Quantum Mechanics: S.L. Gupta, V. Kumar, H.V. Sharma and R.C. Sharma Jai PrakashNath and Company.
6. An introduction to QuantumMechanics, P.T. Mathews c Graw Hill Publishing Company.

PHY 15302: NUCLEAR AND PARTICLE PHYSICS

UNIT – I:Nuclear Forces and Reactions

General properties of nuclei: Parity, isospin, Magnetic dipole moment, electric quadrupole moment and nuclear shape.

Nuclear Forces and Models: Characteristics of nuclear forces – Ground state of Deuteron – Proton – Proton scattering – Neutron – Proton scattering – Meson theory of nuclear forces – Bethe-Weizacker semi-empirical binding energy equation and its applications, Nuclear shell model - energy levels and calculation of angular momentum- its validity and limitations.

Nuclear Reactions: Types of nuclear reactions –Compound nuclear reactions – Bhor's theory- Nuclear cross section – Direct reactions- stripping and pick up reactions - Resonance theory – Briet Wigner one level formula.

UNIT – II: Nuclear Accelerators

Introduction – Ions sources – Classification of accelerators - Electrostatic accelerators – Cockcroft-Walton accelerator, Van de Graff accelerator and Tandem accelerators - Linear accelerators – Drift tube and Wave guide accelerators – Low energy circular accelerators – Cyclotron and Betatron – High energy circular accelerators – Proton and electron Synchrotrons and Microtron.

UNIT – III: Nuclear Reactors

Nuclear fission reactions – Types of fission - Distribution of fission products – Neutron emission on fission – Spontaneous fission – Nuclear fission and thermonuclear reactions – Hydrogen bomb.

Nuclear fusion reactions - Nuclear chain reactions – Four factor formula – The critical size of a reactor – General aspects of reactor design – Classification of reactors – Research reactors and Power reactors.

UNIT – IV:Elementary particles

Discovery and classification of elementary particles – Types of interactions – Conservation laws – Iso-spin, parity, charge conjugation – Time reversal – CPT theorem – Properties of leptons, mesons and baryons – Elementary particle symmetries (SU_2 and SU_3 symmetries) – Quark model – Higg's particle – Elementary ideas.

Reference Books

1. Nuclear Physics, Irving Kaplan, Narosa Pub. (1998).
2. Nuclear Physics, Theory and experiment – P.R. Roy and B.P. Nigam, New Age Int.1997.
3. Atomic and Nuclear Physics (Vol.2), S.N.Ghoshal, S.Chand&Co. (1994).
4. Nuclear Physics, D.C.Tayal, Himalaya Pub. (1997).
5. Atomic and Nuclear Physics, R.C.Sharma, K. Nath& Co., Meerut.
6. Nuclei and Particles, E.Segre.
7. Introduction to Nuclear Physics, H.A. Enge, Addison Wesley (1975).
8. Introduction to Nuclear Physics, K.S. Krane.

PHY 15303: PHYSICS OF SEMICONDUCTOR DEVICES

UNIT - I: Junctions and Interfaces

P-N Junctions, Description of P-N Junction action – Junction in equilibrium- application of bias – energy band diagrams – Types of junctions - Abrupt junction – calculation of the built-in voltage - electric field and potential distributions – Expression for Depletion layer capacitance, Static I-V characteristics of p-n junction diodes: Ideal diode model- Derivation of ideal diode equation. Real diodes – Carrier generation – recombination in the junction depletion region, I-V characteristics of Real Diodes.

Zener and Avalanche breakdown in P-N junctions, Applications of breakdown diodes. Metal-Semiconductor interfaces, Ohmic and Schottky contacts.

UNIT- II: Junction Diodes

Majority carrier diodes: Tunnel diode- I-V characteristics, Equivalent circuits as an oscillator and amplifier, Backwarddiode, Schottky barrier diode - operation and applications.

Microwave devices: Varactordiode-basic principle, equivalent circuit, figure of merit and applications, p-i-n diode operation and its applications.

Transferred electronic devices- Gunn diode, IMPATT diode, TRAPATT diode, BARITT diode - basic principle, operation and its applications.

UNIT - III: Junction Transistors

Bipolar junction transistors: Principle of operation, Carrier recombination in the Emitter-Base junction depletion region – Effect of collector bias variation, avalanche multiplication in the collector – base junction and base resistance.

Junction field-effect transistors: JFET Principle of operation, Static I-V Characteristics of the idealized model.

MOS transistors and charge-coupled devices: MOS capacitor – Surface field effect – Energy band diagrams of an MOS capacitor for different bias conditions - C-V characteristics of the MOS capacitors - Basic Structures and the operating principle of MOSFET, I-V characteristics of an ideal MOSFET, Charge Coupled Devices (CCD)- principle of operation.

UNIT – IV: Semiconductor Technology and Optoelectronic Devices

Technology of Semiconductor Devices: Crystal growth and Wafer preparation, Methods of p-n junction formation, Growth and deposition of dielectric layers, Planar technology, Masking and lithography, Pattern definition, Metal deposition techniques.

Optoelectronic devices: Solar cell- principle of operation- p-n homo-junction Si solar cell – device configuration – electrical characteristics- Photodetectors- Junction –photodiode- Principle of operation, Light Emitting Diode (LED).

Books for Study

1. Introduction to Semiconductor Materials and Devices, M.S. Tyagi, John Wiley & Sons (Asia) Pvt. Ltd., Singapore, 2500.
2. Microwave Devices and Circuits, Samuel and Y. Lao, Prentice-Hall of India, 1999.
3. Microwave and Radar Engineering, M. Kulkarni, UMESH Publications, New Delhi, 1999.

Reference Books

1. Physics of Semiconductor Devices , S.M. Sze, 3rd Edition , Oct.2506, John Wiley.
2. Solid State Electronic Devices, B.G. Streetman, PHI, New Delhi.
3. Semiconductor device fundamentals, Robert F. Pierret, Tata Mcgraw Hills

Specialization Paper

PHY 15304 (A): CONDENSED MATTER PHYSICS – I: Physics of Crystalline Materials

UNIT - I: Crystal Growth and Imperfections in Crystals

Crystal growth: Nucleation and growth – Homogeneous and heterogeneous nucleation – Classification of crystal growth techniques – Melt growth: Bridgman,Czochralski techniques.

Imperfections: Classification of imperfections – Point defects – Schottky and Frenkel defects - Expressions for equilibrium defect concentrations – Colour Centres –Production of colourcentres – Line defects – Dislocations – Edge and Screw dislocations – Burger vector – Estimation of dislocation densities – Mechanism of creep – Experimental determination of creep activation energy.

UNIT- II: Dielectrics and Ferroelectrics

Dielectrics: Introduction – Dipole moment – various types of polarization – Electronic, ionic and orientational polarization –Measurement of dielectric constant – Applications of dielectrics.

Ferroelectrics: Piezo-, Pyro- and ferroelectric crystals– Spontaneous polarization – Classification and properties of ferroelectrics - Ferroelectric domains – Oxygen ion displacement theory – Applications of ferroelectrics.

UNIT- III: Ferromagnetism and Anti-ferromagnetism

Ferromagnetism:Introduction – Weiss molecular field theory – Temperature dependence of spontaneous magnetization – Heisenberg model – Exchange interaction – Ferromagnetic domains – Magnetic bubbles – Bloch wall – Thickness and energy – Ferromagnetic spin waves – Magnons – Dispersion relations.

Anti-ferromagnetism: Introduction – Two sub lattice model of anti-ferromagnetism – Ferri magnetism - Ferrites – Structure – Applications – Multiferroics.

UNIT-IV: Photoconductivity and Luminescence

Excitons: Weakly bound and tightly bound – Photoconductivity – Simple model – Influence of traps – Space charge effects – Determination of photoconductivity. Luminescence – Various types– Thermoluminescence, Electroluminescence, Photoluminescence, Cathodoluminescence and Chemiluminescence - Excitation and emission – Decay mechanisms – Applications.

Reference Books

1.Introduction to Solid State Physics, Charles Kittel VII edition, John Wiley & Sons.
2. Solid State Physics, A.J.Dekker, McMillan Publications.
3.Material Science and Engineering, V.Raghavan, PHI, New Delhi.
4.Crystal Growth, B.R.Pamplin, Pergmon Press.
5.Crystal Growth from High Temperature Solutions, D.Elwell and H.J.Scheel,Academic Press.
6.Solid State Physics, M.A.Wahab, Narosa Publishing House.
7. Fundamentals of Solid State Physics, Saxena, Gupta, Saxena, Pragathi Publications, Meerut.
8. Solid State Physics, R.L.Singhal, KedarNath Ram Nath& Co. Pub.

Specialization Paper

PHYS 15304 B: ELECTRONICS-I: Advanced Electronics

UNIT I – 8086 Microprocessors and its Architecture

8086 Microprocessor Architecture, memory paging. **Addressing modes**: Data addressing modes, program-memory addressing modes, and Stack- memory addressing modes.

Instruction Set: Data movement instructions, Arithmetic and Logic instructions, Program control instructions, Assembler details, Data conversions

UNIT II – Advanced Microprocessors

80386 Architecture – Addressing modes – Instruction sets - 80486 Architecture – Addressing modes – Instruction sets - 80586 Architecture – Addressing modes – Instruction sets – Pentium and Pentium pro basics

Unit - III: Assembler and Assembler Programs

Basic idea – PIC 16 series instruction set and ALU – Assemblers and Assembler format – creating simple programs – Adopting a development environment – Building structured programs – Flow control : Branching and Subroutines – Generating time delays and intervals – Logical instruction – Arithmetic instructions.

Unit - IV: 8051 Microcontroller and PIC 16F873A

Introduction of microcontroller 8051, Internal Architecture, Instruction set, addressing modes, PIC 16F87XA Timer 0 and Timer 1 – 16F87XA Timer 2, Comparator and PR2 register – capture/Compare/PWM (CCP) Module – Pulse width modulation – ADC module.

Interface: LED displays – Liquid crystal displays –Sensors –Actuators.

Books for Study

1. The Intel Microprocessors 8086/80-88,80186/80188.80286,80386, Pentium and Pentium pro processor architecture, programming and interfacing by B. B. Brey 4/e, PHI,1999
2. Microprocessors and interfacing, Programming and hardware by Douglas V. Hall, 2/e McGraw Hill International Edition, 1992.
3. The 80x86 IBM PC and Compatible computer (Volumes I &II) by Muhammad Ali Mazidi and Janice Gillespie Mazidi, 2/e, Prentice-Hall Inc.,1998.
4. Soft ware, Hard ware and applications by Walter A. Tribel and Avatar Singh, PHI, 1995.
5. Microcomputer systems: The 8086/8088 Family Architecture Programming and Design by Yu Cheng Lin and Glenn A. Gibson, PHI 1992.
6. Designing Embedded Systems with PIC Microcontrollers: Principles and Applications by Tim Wilmshurst, First Edition, 2007, Newnes – Elsevier – Publishers.

Reference Books:

1. Microcontrollers: Theory and Applications by Ajay V. Deshmukh, , Tata Mc Graw-Hill, New Delhi, 2005.
2. Designing with PIC Microcontrollers by John B. Peatman, Pearson Education,Inc.,1998.
3. The 8051 Microcontroller and Embedded systems, by Mahammad Ali Mazidi and Janice Gillispie Mazidi, Pearson Education Asia, Pvt. Ltd., 2000.

Non-Core Elective Paper

PHY 15307: ADVANCED ANALYTICAL INSTRUMENTS

Unit I: Spectroscopic Measurement Techniques

Introductionto Spectroscopy – Propertiesof Electromagnet Radiation – EM Spectrum –Beer's law – Absorptivity – UV and visible absorption- Essential parts of Spectrophotometer- Gratings and prisms – Radiant energy sources – filters –detectors- Photomultiplier tubes -Instrumentation –-Single Beam, Double BeamSpectrophotometer-Applications.

Unit II: Bio-physical Measurement Techniques

Principles of blood pressure equipment, glucometer, Ultrasonography, cardiovascular measurement circulatory systems of heart- ECG anatomy and function of heart. Generation of X-rays -X-ray diffractograph- CT- Scan -Applications - Introduction to nuclear magnetic resonance, NMR – Chemical shift – spin – spin coupling _Instrumentation- Magnetic resonance Imaging (MRI)

Unit III: Weather Measurement Techniques

Introduction to TropicalWeather, Climate, Lighting, Cyclones and Monsoons.
Climatic Station, Rain gagues, Automatic Weather Station, Global Positioning System, Radisonde, Radar and weather Satellites

Unit IV : Air pollutions Measurement Techniques:

Introduction to Greenhouse Effect -Enhancement of the Greenhouse Effect;
Primary gaseous pollutants (CO_2, CH_4, CO AND NOx)- sources and their effects on climate/human health. Secondary gaseous pollutants (Ozone and PAN)- Formation and their effects on human health.
Gaseous pollutants measurement techniques – principles, block diagrams and working.Effects of aerosols on climate and human health. Measurement techniques- direct measurements by sampling and remote sensing measurement by Multi wave solar radiometer and LIDAR.

Source: The relevant material of the above units must be down loaded from authenticated web location from https://www.google.com

PHY 15401: QUANTUM MECHANICS-II

UNIT- I: Identical Particles and Molecules

Identical particles- Indistinguishability of Identical particles- Construction of Symmetric and Anti-symmetric wave functions for two and three particle systems - Pauli's Exclusion Principle- Hydrogen molecule- Spin-orbit interaction- Ortho and Para hydrogen- Spin statistics connection.

UNIT - II: Angular Momentum

Introduction: Definition of angular momentum operator - Commutation rules for angular momentum - Eigen values and Eigen functions of L_z and L^2 - Angular momentum in general - Allowed values of angular momentum J - Eigen values of J_+ and J_- angular momentum matrices - Addition of angular momeeta and Clebsh -- Gorden co-efficients: Clebsh – Gorden co-efficient for $J_1=J_2=1/2$ and $J_1=1$, $J_2=1/2$ - spin angular momentum and Pauli's spin matrices.

UNIT - III: Relativistic Quantum Theory

Klein – Gorden Equation – Probability Current Density – Inadequacies of K.G. Equation – Dirac's Relativistic Equation for a Free Particle - Dirac`s Matrices – Dirac`s Equation in Co-variant form – Plane wave solution – Negative Energy States – Spin Angular Momentum - Existence.

UNIT - IV: Quantization of Wave Fields

Concept of Field - Method of Canonical Quantization: Lagrangian Formulation of Field, Hamilton Formulation of Field - Second Quantization – Field equation - Quantization of Non-relativistic Schroedinger equation – Commutation and Anti-commutation Relations, The N-representation - System of Fermions and Bosons – Creation and Annihilation.

Reference Books

1.QuantumMechanics:S.L.Kakaniand H.M. ChandaliaSultanChandandSonsFirst Edition
2. Advanced Quantum Mechanics : B.S. Rajput, Pragatiprakasan
3. Quantum Mechanics : V.K. Thankappan, Wiley Eastern Limited
4. A Textbook of Quantum Mechanics : P.M. Mathews and K. Venkatesan, Tata McGraw Hill Publishing Company
5. Quantum Mechanics : S.L. Gupta, V. Kumar, H.V. Sharma and R.C. Sharma, Jai PrakashNath and Company
6. An Introduction to Quantum Mechanics, P.T. Mathews McGraw Hill Publishing Company

PHY 15402: ANALYTICAL TECHNIQUES

UNIT- I: Diffraction Methods for Structure Analysis

Crystal systems: Symmetry elements, Concept of point groups and space groups. Reciprocal Lattice: Geometrical construction, Relation between direct – Reciprocal Lattice X- ray diffraction, Bragg's law, Laue methods, Powder X-ray Diffractometer– Focusing circle geometry-Determination of lattice constant of a cubic and tetragonal structures using d-spacings, Single crystal X-ray Diffractometer- Electron diffraction and Neutron diffraction: Basic principles and applications.

UNIT - II: Electron Spin Resonance and Mossbauer Spectroscopy

Electron spin resonance spectroscopy: Magnetic moment of an electron, two states of an electron in a magnetic field, ESR theory- Spin-spin interaction, Spin-lattice interaction - Hyperfine interaction-g factor, Line widths and Intensities, Relaxation effects, Experimental methods and applications.

Mossbauer spectroscopy: Introduction-Mossbauer effect, Recoilless emission and absorption, Mossbauer spectrum, Mossbauer nuclides-Experimental methods - Isomer shift - Hyperfine interactions and applications.

UNIT – III: NMR and NQR Techniques

Introduction to NMR: Nuclear spin and magnetic moment, Quantum description of NMR, theory of NMR, chemical shift, Spin-lattice (T_1), spin-spin (T_2) couplings, Bloch equations, Theory of relaxation mechanisms for spin ½ nuclei, Proton NMR, Carbon-13 NMR and NMR applications.

Basic concepts of NQR spectra: Half integral and integral spins, Instrumentation, Super regenerative oscillator, CW oscillator, Pulse RF detection and applications.

UNIT – IV: Advanced Spectroscopic and Microscopic Techniques

Basic principles, Instrumentation and applications of X ray fluorescence spectroscopy, Photoelectron spectroscopy, Photo Acoustic spectroscopy. Basic principles, Instrumentation and applications of Scanning electron microscopy, Transmission electron microscopy, Atomic force microscopy, Energy dispersive spectroscopy, Differential scanning calorimetry and Thermo gravimetric analysis.

Text Books and Reference Books

1. Elements of X-ray Diffraction, B.D. Cullity.
2. Methods of Surface Analysis, Techniques and Applications, J.M. Walls Cambridge University Press, 1990.
3. Neutron Diffraction, G.E. Bacon, Oxford University Press, London, 1962.
4. Electron Diffraction, T.B. Rymer, Methnen, London, 1970.
5. X-ray Structure Determination, H. Stout and LH. Jenson, Macmillan, London, 1968.
6. An Introduction to Electron Paramagnetic Resonance, M. Bersohn, J.C. Baird, Benjamin Inc., London, 1966.
7. Instrumental Methods of Analysis, Willard Merritt, Dean Settle, CBS publishers, New Delhi, 1986
8. Spectroscopy, B.P. Straughan and S. Walker, John Wiley & Sons Inc., New York,1976.
9. Spectroscopy, G. Chatwal and S. Anand, Himalaya Pub., 2502.
10. Spectroscopy, B.K. Sharma, Goel Publishers House, Meerut, 1975.
11. NMR Spectroscopy, R.K. Harris, Longman Sci. Tech, 1983.

Elective Paper
PHY 15403 (A): ATMOSPHERIC PHYSICS

UNIT I- Earth's atmosphere

Layers of the atmosphere, variation of temperature with height in the atmosphere; Atmospheric pressure; Composition of the atmosphere-expressing the amount of a substance in the atmosphere; Energy balance of earth and atmosphere, Green house effect, Solar and terrestrial radiation; Block body radiation, laws of black body radiation -Plank's Law, Stefan – Boltzmann Law, and Wien's Displacement Law.

UNIT II - Meteorological Instrumentation

Ground based climatic station and automatic weather station for the measurement of air temperature, humidity, atmospheric pressure, wind speed, velocity and Rainfall.
Upper air observations- Rawinsonde, Radiosonde, GPS sonde-estimation of convective boundary layer height, thermo dynamical parameters and construction of T-Phigram;

UNIT III – Air pollution and its measurement techniques

Primary gaseous pollutants (CO_2, CH_4, CO AND NOx)- sources and their effects on climate/human health. Secondary gaseous pollutants (Ozone and PAN)- Formation and their effects on human health. Gaseous pollutants measurement techniques – principles, block diagrams and working. Description of aerosols, sources of aerosols, aerosol production mechanisms, effects of aerosols on climate and human health. Measurement techniques- direct measurements by sampling and remote sensing measurement by Multi Wavelength solar Radiometer and LIDAR.

UNIT IV – Radar Principles and Meteorology

Introduction to RADAR, Types of Radars- Mono-static, Pulsed radar, FM-CW radar; Basic principles of Pulsed (Wind Profiler) radar- Antenna Basics- radar signal processing ; Types of Radar Scattering theory- Wind Vector calculations; Wind Profiler Applications- Aviation, Tropical Cyclone, Thunderstorm, meteorological (Synoptic and Mesoscale) and Environmental.

Prescribed Books:

1. Battan, L.J. Radar Observation of the Atmosphere, University of Chicago Press, 1973, USA
2. Doviak, R.J., and D.S. Znic, Doppler Radar and Weather Observations. Academic Press, San Diego, Calif., 1993, USA
3. B.R. Bean and E. J. Dutton, radio meteorology, U.S. Govt, print. Off (Washingtion), 435p.1996.
4. Handbook of the Atmospheric Science- Principles and Applications by C. N. Hewitt and Andrea V. Jackson Black well publishing company, USA, 2003.
5. Atmospheric Chemistry and Physics by John H. Seinfeld and Spyros N. Pandias
6. Air Pollution by JermyColls, Spon Press, New York, 2002.
7. Atmospheric Pollution by Aerosols by V.K. Sharma, Scientifi Publishers, Jodhpur, 1994.

Elective Paper
PHY 15403 (B):APPLIED SPECTROSCOPY

UNIT I – Spectrophotometry

Introduction- Beer's law – Absorptivity – UV and visible absorption- Instrumentation- Essential parts of spectrophotometer- Gratings and prisms – Radiant energy sources – filters – Photosensitive detectors- Barrier layer cells – Photo emissive cells – Photomultiplier tubes – Relationship between absorption in the visible and UV region and molecular structure – IR spectrophotometry - Fourier Transform Infrared (FTIR) Spectrometer – Molecular structure.

UNIT II - Fluorescence and Phosphorescence Spectroscopy

Introduction – Flourescence- Resonance Flouorescence- Normal Fluorescence-Intensities of Transitions – Non-radiative decay of fluorescent molecules – Phosphorescence and the nature of the rriplet state- Population of the triplet state – Delayed fluorescence- Excitation spectra - Experimental methods – Emission lifetime measurements – Time resolved emission spectroscopy – Applications of Fluorescence and Phosphorescence

UNIT III - Raman Spectroscopy

Introduction- Theory of Raman Scattering – Rotational Raman Spectra- Vibrational Raman Spectra – Mutual Exclusion principle – Raman Spectroscopy/ Sample Handling Techniques-polarization of Raman Scattered Light – Single Crystal Raman Spectra – Raman Investigation of Phase Transitions – Resonance Raman Scattering – Structure Determination using IR and Raman Spectroscopy.Difference between Raman spectra and Infrared spectra.

UNIT IV - Non-linear spectroscopic phenomena

Non-linear Raman phenomenon - Hyper Raman spectroscopy – Stimulated Raman spectroscopy – Inverse Raman effect – Coherent Anti-stokes Raman scattering – Photo-acoustic Raman scattering – Multi Photon Spectroscopy

Prescribed Books:

1. Molecular spectra and Molecular structure Volume I, **G. Herzberg** (2nd Edition, Van. Nostrand London)
2. Fundamentals of Molecular Spectroscopy,**C.N. Banwell**(Tata Mcgraw- Hill Publishing Company Ltd, 1983)
3. Spectroscopy,**Straughan and Walker** (volume 2 and volume3, John wiley and Sons, 1976)
4. Molecular Structure and Spectroscopy,**G. Aruldhas**(Printice- Hall of India, Pvt. Ltd. 2001)
5. Instrumental Methods of Analysis,**Willard, Merritt, Dean and Settle** (CBS Publishers and Distributor, New Delhi, 200)

Elective Paper
PHY 15403 (C):VACUUM AND THIN FILM PHYSICS

UNIT I – Production and Measurement of Vacuum

Fundamentals of kinetic theory of gases – Vacuum fundamentals

Production of Vacuum: Mechanical oil sealed Rotary pumps - Roots pump – Turbo molecular pump - Vapor pumps – Diffusion pump - Sorption pump

McLeod gauge- Thermal conductivity gauges-Pirani gauge – Cold cathode Ionization gauges-Penning gauge – Hot cathode ionization gauge - Bayard- Alpert gauge- Quadruple mass spectrometer

Vacuum application – Tungsten filament and discharge lamps – Electron tubes- Vacuum metallurgy- Space simulators and freeze drying

UNIT II - Methods of Thin film Preparation

Physical methods: Vacuum evaporation, Types of evaporation sources - Resistive heating electron beam evaporation – Co-evaporation - Two source evaporation and three source evaporation - Flash evaporation- Laser ablation - Reactive evaporation - Epitaxial deposition-Hot wall epitaxy and Molecular beam epitaxy

Sputtering: Glow discharge, DC sputtering, RF sputtering, Magnetron sputtering, Reactive sputtering

Chemical Methods: Electroplating – Spray Pyrolysis – Chemical vapor deposition (CVD)

UNIT III - Growth and Thickness measurement of Thin Films

Condensation – Nucleation – and growth of thin films – Langmuir Frenkel theory of condensation – Theories of thin film nucleation – Capillarity theory – Statistical or Atomistic theory – Comparison of nucleation theories – The four stages of film growth – Incorporation of defects during growth

Thickness Measurement: Multiple beam Interferometer (MBI) – Quartz Crystal Thickness Monitor

UNIT IV – Properties of Thin Films

Sources of electrical resistivity in metallic conductors – Sheet resistance – Temperature coefficient of resistance – Influence of thickness on the resistivity – Fuchs-Sondheimier theory – Hall Effect

Reflection and Transmission at an Interface - Reflection and Transmission by a single film – Reflection from an absorbing film – Multilayer films – Determination of optical constants by ellipsometry

Applications of thin films

Thin film resistors – Capacitors – Beam splitters – reflection and anti reflection coatings – Optical filters

Prescribed Books:

1. "Vacuum Technology" A.Roth, North Holland, 1986.
2. "Vacuum Science and Technology" V.V. Rao, T.B. Ghosh and K.L. Chopra, Allied Publications, 1998.
3. "Fundamentals of Vacuum", Ward & Bann
4. "Hand book of Thin Film Technology" L.I. Maissel and R.L. Glang, McGraw Hill Bool Co., 1970.
5. "Thin Film Phenomenon" K.L. Chopra, McGraw Hill Bool Co., New York1969.
6. " Hand Book of Technologies for Films and Coatings" R.F. Bunshah, Noyes Publication, 1996.
7. "The Material Science of Thin Films", M. Ohring, Acddemic Press, New York, 1992.
8. "Preparation of Thin Films", JoyGeorge

Elective Paper
PHY 15403 (D):PHOTONICS

UNIT - I: Fibre Optic Components and Sensors

Connector principles, Fibre end preparation, Splices, Connectors, Source coupling, Distribution networks, Directional couplers, Star couplers, Switches, Fiber optical isolator, Wavelength division multiplexing, Time division multiplexing, Fiber Bragg gratings. Advantage of fiber optic sensors, Intensity modulated sensors,

Mach-Zehnder interferometer sensors, Current sensors, Chemical sensors –Fiber optic rotation sensors. Optical biosensors: Fluorescence and energy transfer sensing, molecular beacons and optical geometries of bio-sensing, Bio-imaging, Biosensing.

UNIT - II: Integrated Optics

Introduction – Planar wave guide – Channel wave guide – Y-junction beam splitters and couplers - FTIR beam splitters – Prism and grating couplers – Lens wave guide – Fabrication of integrated optical devices - Integrated photodiodes – Edge and surface emitting laser – Distributed Bragg reflection and Distributed feed back lasers - Wave guide array laser.

UNIT - III: Optical Signal Processing

Introduction, Effect of lens on a wavefront, Fourier transform properties of a single lens, Optical transfer function, Vanderlugt filter, Image spatial filtering, Phase-contrast microscopy, Pattern recognition, Image de-blurring, Photonic switches, Optical transistor, Optical Gates- Bistable systems, Principle of optical Bistability, Bistable optical devices, Self electro-optic effect device.

UNIT - IV: Photonic Crystals

Basics concepts, Theoretical modeling of photonic crystals, Features of photonic crystals, Methods of fabrication, Photonic crystal optical circuitry, Nonlinear photonic crystals, Photonic crystal fibers, Photonic crystals and optical communications, Photonic crystal sensors.

Text and Reference Books

1. Fibre Optic Communication, Joseph C. Palais, Pearson Education Asia, India, 2001
2. Introduction To Fibre Optics, A.Ghatak And K.Thyagarajan, Cambridge University Press, New Delhi, 1999
3. Optical Guided Wave Signal Devices, R.SymsAndJ.Cozens. Mcgraw Hill, 1993.
4. Optical Electronics, A Ghatak and K. Thyagarajan, Cambridge University Press, New Delhi, 1991
5. Fundamentals of Photonics, B.E.A. Saleh and M.C. Teich, John Willy and Sons,1991
6. Introduction to Fourier Optics, Joseph W. Goodman, McGraw-Hill, 1996.
7. Nanophotonics, P.N.Prasad, Wiley Interscience, 2003.
8. Biophotonics, P.N.Prasad, Wiley Publications, 2004.

Specialization Paper

PHY 15404 (A): CONDENSED MATTER PHYSICS – II

UNIT - I: Elastic Properties of Solids

Lattice as a homogeneous and continuous medium - Analysis of stress and strain tensors – Hooke's law - Elastic compliances and stiffness constants – Elastic energy density – Reduction in the number independent elastic constants in cubic crystals – Cauchy's relations – Bulk modulus and compressibility – Elastic waves in cubic crystals – Formulation and solution of wave equations along [100], [110] and [111] directions – Experimental determination of elastic constants – Pulse-echo technique.

UNIT - II: Thermal Properties of Solids

Quantum theory of lattice vibrations – Properties of phonons – Lattice specific heat at low temperatures – Einstein and Debye models – Born cut-off procedure – Inelastic scattering of neutrons by phonons – Experimental study of dispersion curves – Inadequacy of harmonic model – Anharmonicity – Thermal expansion – Gruneisen parameter- Lattice thermal conductivity – Elementary kinetic theory – Role of U and N processes.

UNIT - III: Energy band theory and Fermi Surfaces

Energy band theory: – Periodic potentials – Bloch's theorem and functions – Electron motion in periodic potentials – Origin of energy gap – Brillouin zones – Reduced zone and periodic zone schemes – Brillouin zones for simple cubic, bcc and fcc lattices, Tight binding model.

Importance of Fermi surface – Characteristics of Fermi surface – Construction of Fermi surface - Quantization of electron orbits - Experimental study of Fermi surface: Anomalousskin effect – Cyclotron resonance – de Haas van Alphen effect.

UNIT - IV: Nano - structured Materials

Definitions _ Nano- crystalline – XRD patterns –General Methods of preparation of Nano structured materialss by Physical and Chemical routes. Inert Gas condensation Chemical Vapor Deposition, and sol – zel process, Growth of nanocrystals in Glasses through thermal treatment (Glass ceramics). Particle size estimation by XRD/SPM,/STM/AFM Techniques. Size quantization effects, Band gap expansion (Blue shift) in semiconductors, quantum wells, wires and Dots- density of states. Applications of nano materials with specific examples.

Reference Books

1.Introduction to Solid State Physics, Charles Kittel7th Edition, John Wiley & Sons.
2.Solid State Physics, A.J.Dekker, MacMillan.
3.Solid State Physics, H.C. Gupta, Vikas Publishing House.
4.Elementary Solid State Physics, M.Ali Omar, Addison Wesley.
5.Solid State Physics, M.A.Wahab, Narosa Publishing House.
6.Science of Engineering Materials, C.M.Srivastsava and C.Srinivasan, New Age Inter. Pub.

Specialization Paper

PHY PHY 15404 (B): ELECTRONICS-II: COMMUNICATION SYSTEMS

UNIT I - Computer Communications Systems

Types of networks, Design features of computer communication networks – ISDN, LAN Time Division Multiple Access (TDMA), Frequency division multiple Access (FDMA), ALOHA, slotted ALOHA and carrier sense multiple Access (CSMA), Introduction to CDMA.

UNIT II - Fiber Optics Communication

Optical Fiber System : Intensity modulation/direct detection, optical transmitter circuit, Optical receiver circuit, system design considerations, Digital Systems & planning considerations, Analog systems, distribution systems, Advanced multiplexing strategies.

Coherent Optical Fiber Systems: Basic Systems, Detection principles, Practical Constraints, Modulation formats, Demodulation schemes, Receiver sensitive, Signal and Multi carrier systems.

Unit – III: Introduction to wireless communication systems

Global system for mobile (GSM): cellular concept, system design. Transmission system, Receiving system; frequency re-use; Spread spectrum modulation; Multiple access techniques as applied to wireless communications; 1G, 2G, 3G wireless networks.

Unit – IV: Satellite and Optical communications

Introduction Satellite systems: Orbiting satellites, satellite frequency bands, communication satellite system-modulation and multiple access format-satellite systems in India, Satellite receiving systems, G/T ratio, satellite uplink and down link analysis. Applications to communications and remote sensing. Introduction to Optical communications systems: Optical fibers, sources and detectors, analog and digital systems.

Text Book

1. Modern Digital and Analog communication system, B.P. Lathi: Oxford 3 rdEdition.
2. Digital Communications Fundamentals and Applications, Bernard Sklar, Sklar Pearson Education.
3. Taub and Schilling, "Principles of Communication Systems", Second edition, Tata McGraw Hill edition, 1991
4. Simon Haykin, "Communication Systems, Third Edition", John Willey & Sons, Inc.1994.
5. Wayne Tomasi, "Advanced Electronics Communications Systems",IV Edi, P. Hall,Inc,1998
6. John M. Senior, "Optical Fiber Communications", Second Edition, PHI, 1999
7. Gerd Kesier "Optical Fiber Communications" Second Editaion, McGrw- Hill International Editions,1991.
8. Principles of Communication, R.E. Ziemer, WH Tranter 5th Edition John Wiley (Fifth module).

Reference Books

1. Morden Electronic Communication Systems, Wayne Tomoasi, Person Education/PHI.
2. Digital Communication, John G Proakis, MGH.
3. Digital Communication Techniques Simon, Hindey Lindsey PHI.
4. Communication Systems, Simon Haykin, John Wiley & Sons. Pvt. Ltd.
5. Principles of Communication Systems, Taub and Schilling, Tata McGraw-Hill.
6. Digital and Analog Communication System, K. Sam Shanmugam. John Wiley.
7. Communication Systems Engineering, Proakis, Pearson Education.
8. Digital and Analog Communication System, Leon W Couch, Pearson Education/PHI.
9. Introduction to Statistical Signal Processing with Applications, M.D. Srinath, P.K.
10. Rajasekaran, R.E. Viswnathan PHI.
11. Analog and Digital Communication, M.S. Roden PHI.
12. Digital Modulation and Coding. Wilson, Pearson Education.
13. Applied Coding and Information Theory for Engineers, Wells, Pearson Education.

M.Sc. DEGREE EXAMINATIONS,

I, II, III & IV SEMESTERS

PHYSICS

PHYS 15101 to 15104, 15201 to 15204, 15301 to 15304 &15401 to 15404: <u>TITLE OF THE PAPER</u>

(Revised Syllabus with effect from 2018 - 2019**)**
(No additional sheet will be supplied)

Time: 3 hours **Max. Marks: 75**

PART – A (Marks: **5x3 = 15**)

Answer any **FIVE**questions. Each answer should not exceed ONE (1) Page
All questions carry equal marks

1. From **UNIT - I**
2. From **UNIT - I**
3. From**UNIT - II**
4. From**UNIT - II**
5. From**UNIT - III**
6. From**UNIT - III**
7. From**UNIT - IV**
8. From**UNIT - IV**

PART B (Marks: **4 x 15 = 60**)
Answer **ALL** questions.
Each answer should not exceed SIX (6) Pages

9. **OR** 10. **UNIT – I (With internal Choice)**

11. **OR** 12. **UNIT – II (With internal Choice)**

13. **OR** 14. **UNIT – III (With internal Choice)**

15. **OR** 16. **UNIT – IV (With internal Choice)**